

Progress of short-term earthquake prediction study by using electromagnetic phenomena

Toshiyasu Nagao[1]

[1] Earthquake Prediction Res. Center, Tokai Univ.

<http://yochi.iord.u-tokai.ac.jp>

Thanks to the progress of the digital technology, we are now able to detect a number of interesting phenomena preceding large earthquakes in various frequencies. After the devastating Kobe Earthquake in 1995, Science and Technology Agency (STA) decided to initiate five year programs of RIKEN International Frontier Research Project on Earthquakes and NASDA Earthquake Remote Sensing Frontier Research Project for promoting the earthquake prediction research by using the electromagnetic methods. Both programs generated many significant contributions. Concerning Kobe Earthquake, observed anomalous electromagnetic phenomena were compiled by Nagao et al., (2002, *J. Geodynamics*, 33, 401-411.). Furthermore, significant anomalous changes in the ULF range were observed in both geoelectric and geomagnetic fields before the major volcanic seismic activity in the Izu Island region, Japan in the summer of 2000 (Uyeda et al., 2002, *Proc. Natl Acad. of Sciences, USA (PNAS)*, 99, 7352-7355.). In this swarm activity we developed a direction finding technique using the array observation of the three-component magnetic data, and we successfully extracted the signal from the epicentral direction. These are just the results of innovation of the digital technology. Moreover, the signals of the specific waveforms from the epicentral direction in VLF range are observed several days before impending earthquakes (Asada et al., 2001, *Earth Planets Space*, 53, 55-62.). In the VLF range, Tsutsui (2002, *GRL*, 29, 8, 10.1029/2001GL013713, 35), using a newly designed underground antenna, observed an anomalous signal which probably traveled through the underground wave guide for the first time, although such was predicted theoretically more than thirty years ago. Very active researches are being made also in the VLF and VHF range signals. Researches on the earthquake-related anomalous propagation of EM waves are also energetically carried out in the VLF (Molchanov and Hayakawa, 1998, *JGR*, 17489-17504.) and VHF (e.g. Kushida and Kushida, 2002, *J. Atmospheric Electricity*, 22, 239-255.) ranges. The most interesting observational fact in recent years is the existence of the ionospheric anomalies before/during/after the major shallow earthquakes (e.g. Liu et al., 2001, *GRL*, 28, 1383-1386.). They are producing a new concept called LAI (Lithosphere-Atmosphere-Ionosphere) coupling. The author considers that the new generation of seismo-electromagnetism researches is making a major breakthrough now. In the presentation, we introduce the latest knowledge of seismo-electromagnetism, and its future scope.